CHOOSING AND SITING ANTENNAS FOR TELEPOINT SERVICES

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This short article describes new antennas which have been designed for the Telepoint phone service and suggests how they should be sited to provide the best coverage.

Introduction

The new Telepoint service operates in the 860MHz band and uses a large number of low-power base stations. Each base station has an output power of only 10mW and provide a coverage cell extending to a maximum of about 200m from the antenna. The intentional limitation of the size of each cell allows for very intensive frequency re-use, with very close packing of cells in urban areas.

The use of very low power base stations makes it important that antennas are efficient and well sited if proper coverage is to be obtained. The channel to be used for a call is automatically selected from the set of channels which is available to the base station through which the call is set up, as being the channel with the lowest signal-to-noise ratio. The system is fully digital, two-way communication is provided by time-sharing the use of a single channel.

It is important to remember that with a digital system an increasing signal-to-noise ratio (snr) at first causes little degradation but, at an input threshold determined by the error-correcting circuits, the output signal disappears suddenly once the snr falls below a critical level. Areas which have reasonably uniform field strength will provide a stable communications channel; areas with rapidly varying field will produce drop-out problems which a user will find unacceptable.

Types of Antenna

Three types of antenna are currently available for base stations. Omnidirectional antennas provide gains of 2 - 6dBi and are intended for use where all-round coverage is needed. Directional antennas come in a basic flat package containing a simple radiating element known as a patch, or as slightly larger higher gain units, which contain a dipole and reflecting plate. These directional antennas are intended for mounting on a wall and provide solid coverage of the area in front of them. Figure 1 shows polar patterns.of some typical antennas.

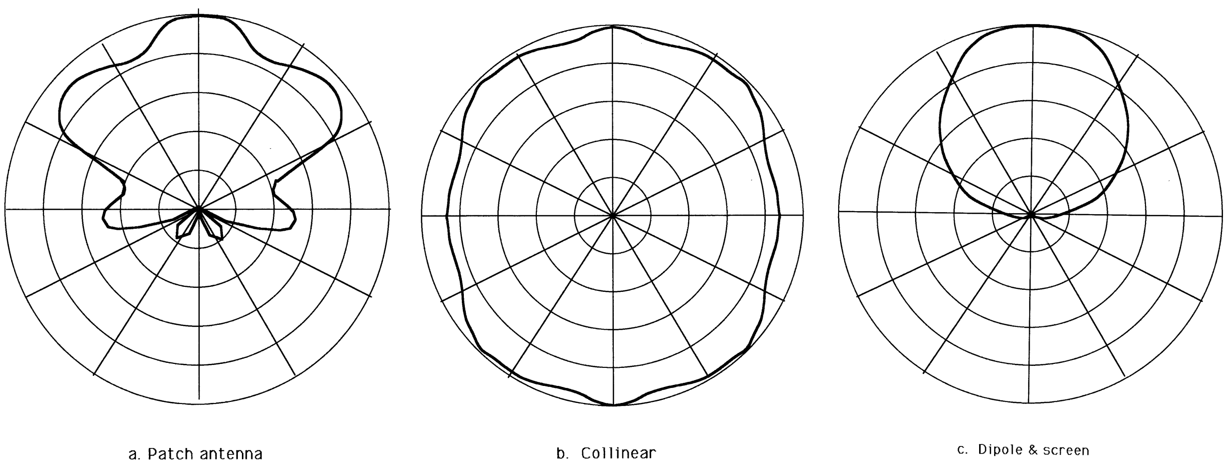

Figure 1: Azimuth patterns for typical base station antennas

All the antennas use simple methods of design and construction, printed circuit (stripline) techniques provide low-cost, reliable antenna structures in the CT2 frequency band and have been used to provide the necessary close mechanical tolerances in construction.

At 860MHz the effects of water getting into antennas is very serious, and even small amounts of corrosion will cause rapid loss of the radiated signal. Well-designed antennas use simple designs and must avoid joints between dissimilar metals which will corrode quickly (especially joints between aluminium and copper). The antennas have light plastic radomes to keep rainwater off the antenna - make sure the antenna is mounted the right way up if a drain hole has been provided to allow condensation to escape.

As very large numbers of base stations will be installed over the next few years, many of them in prominent locations in public places, particular care has been given to the appearance of antennas and their mountings. CSA's directional antennas have small mounting devices which are completely hidden by the antenna so no ugly screws or brackets can be seen - only a pleasingly contoured radome, smaller than a typical burglar alarm fitting, is visible. The arrangement is convenient to install, as the mount is self-jigging and provides easy access for marking and drilling the wall

Installation

The antennas which have been described provide patterns which are suitable for most typical sites. Omnidirectional antennas are suited to many out-of-town sites where they can be mounted above one or two-storey buildings and will provide effective coverage of the building and surrounding area. Where solid coverage of the inside of a building is needed, a directional antenna such as CSA's Unipoint, can be mounted on a wall, firing into the building; this reduces the leakage from the building and reduces the possibility of interference to or from users in other cells close by. An antenna with a very large beamwidth (CSA Patchpoint) can be mounted firing down from the ceiling of a large room or stair-well. '

If an omnidirectional antenna is mounted alongside obstructions - buildings, metal guttering, plumbing outlets, advertising signs - the resulting radiation from the antenna will be directional, with a directional pattern determined by the materials, size, shape and separation of the obstruction. The arrangement has an unpredictable pattern and gain. A directional antenna firing away from the obstruction will provide much more certain performance; if necessary move the antenna location so that the directional antenna will illuminate the target area.

In an urban location, the signal radiated from the antenna is reflected from other buildings close by, usually in a fairly random manner. These reflections give rise to severe spacial variations in signal level which a user will perceive as signal fades (the fades occur as he moves about, sampling the level of field in different locations). This spacial fading limits urban coverage; the user hears clicking on his conversation, and the call can be lost if the effect is severe. Antennas must be chosen and sited to produce direct, reflection-free coverage wherever possible; the temptation to extend cover into areas with high levels of reflected signals will result in a high proportion of lost calls and dissatisfied users.

Diffraction losses at 860MHz are high. Where no line-of-sight path exists between the base-station antenna and part of the intended target area, effective coverage can be provided by a reflected path, preferably with no more than a single reflection of the signal. A shadowed area into which signal can be reflected by several different routes is likely to suffer from spacial fading.

Multiple Antennas

In some situations it is possible to extend coverage by connecting two separate antennas to a base station. Remember that the effective power radiated from each is halved, and try to make sure that no areas are illuminated from both the antennas, because path length differences will result in deep signal nulls. This method will allow good coverage of the area in front of and behind a building (but not at the same time inside it) or, for example, inside and outside a warehouse or DIY store.

Penetration Through Buildings

The loss in penetrating most dry building materials is usually less than 3dB, but this figure rises rapidly when the materials are saturated with rainwater.

Where a building is clad with modern aluminium fascia panels (as the example of the DIY store mentioned above), or where aluminium foil is used in thermal insulation panels to reflect heat, the penetration loss through walls is large. Unless the wall is broken up by large clear glass windows separate coverage of the inside and outside ares should be considered.

Choosing the Antenna Location

Be careful of the simple assumption that the higher the antenna is placed, the better coverage will be; it may be true in an unobstructed rural site, but may lead to unexpectedly poor results in towns. Remember that users need a strong, reflection-free signal and concentrate on illuminating the primary target area to achieve this. Think of the buildings surrounding the target area as mirrors and place the antenna so you can't see it reflected in the walls around. Directional antennas can often be fired slightly downwards to help in avoiding these troublesome multiple reflections. Avoid firing directly across a street, even if you want to cover the area directly in front of the building; better choose a slightly offset location and fire slightly downwards from above.

There is a small null area directly below most types of antenna. This problem is mitigated by slight down-tilting of the main beam. Low gain antennas like those which have been described have broad vertical beam-widths, so the reduced signal in front of the antenna is usually offset by the fact that users who are much below the main beam are standing fairly close by.

Feeder Losses

The attenuation of typical small coaxial cables at 860MHz is very large (see Table 1). When planning a site make sure that the mains supply and phone lines can be extended to allow the base station unit to be placed within 5m or so of the best antenna position.

Cable type	Attenuation of 10m at 860MHz (dB)
UR43	1.2
UR67 (RG214)	0.7
1/2in foam	0.6

Conclusion

The Telepoint system represents the first generation of digital radio equipment provided for a mobile consumer application and both users and installers will need to accustom themselves to this new medium. Early publicity about coverage and ease of use has not been good, but the system is capable of providing a first-class service with the technicalities of the radio bearer entirely transparent to the user. This article has indicated some of the principles which need to be observed if the best results are to be obtained.